Volume 30 November, 1944 *Number 11*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of
Portable Air Tools

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

REGAL STARFAKS AND ROTARY VANE TOOLS

THE MODERN high speed rotary vane type of air tool is a most precise mechanism. It is designed to function at rotor speeds which may approach 8000 R.P.M.; it must see service under widely varying atmospheric conditions; it must be capable of operating on virtually any kind of compressed air; it must be durable. All these conditions can be met provided the tool is kept properly lubricated in service and *free from rust* during storage.

Among the mechanisms which go to make up the modern rotary vane tool are gears for speed reduction purposes; precision ball bearings which carry the rotor; and the hammer mechanism of the impact wrench. These parts are grease lubricated.

Their protection was one of the incentives which prompted the development of *Texaco Regal Starfak Greases.* Lubrication, stability, resistance to oxidation, all mean longer-wearing bearings and gears, less leakage, longer periods between cleaning. *Regal Starfaks* afford these benefits and during storage protect the vital steel surfaces against rusting.

THE TEXAS COMPANY

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication of Portable Air Tools

THE modern high speed air tool is an assembly of precision mechanisms built to very close clearances. Any resistance imposed upon free motion of these related parts may lead to serious increase in power consumption with loss in efficiency and excessive wear. Efficient use of air has a direct relation to the power bill.

In cold weather the selection of suitable lubricants for air tools which may be exposed to the elements is especially important. Low temperature increases the resistance to flow in petroleum lubricants, rendering them sluggish and less likely to reach all the wearing parts. Hence the importance of studying the low temperature characteristics including viscosity when selecting such lubricants.

Tool designers have progressed markedly in their studies of ways and means to insure air tool protection through dependable lubrication. They have given particular attention to lubricator construction and by oil tight seals have prevented leakage of lubricant as well as entry of abrasive foreign matter.

Dust and dirt may be especially harmful to parts if it works into the mechanisms for it will promote wear, cause increased clearances, and lead to noisy operation with marked decrease in efficiency. Thorough understanding of design, lubricator application and the physical limitations of the available lubricants, will go a long way toward eliminating these difficulties.

TO produce fighter planes capable of flying at speeds of around 400 miles an hour at the rate of some 10,000 a year, requires comparable speed on the production and assembly lines. It is interesting to note how the use of air power has contributed to this rate of production. Air power to produce air power.

Air power and air tools in production came into being along with the perfection of mass production methods. Study of the transition in air tool development indicates that from the beginning the designers built precision mechanisms. Riveters, drills, chippers, calkers, grinders, all the forerunners of the modern tools for the same purpose, were sturdy and dependable.

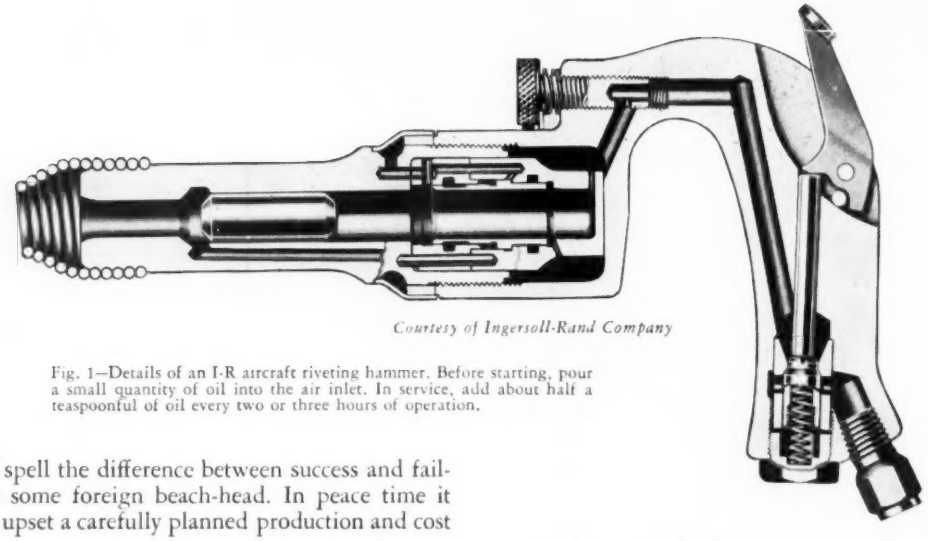
But all these tools were not high speed. Today we must have speed to produce speed. Rotary vane pneumatic tools were the means toward this end. This design, which involves a type of air motor, enabled doubling, even re-doubling of the conventional speeds of the early thirties. Today 10,000 r.p.m. motor speed is practicable. This results in tools of much higher power and output capacity for the size and weight.

HOW THEY WORK

Air tools are portable, self-contained in regard to the propelling and operating mechanisms, and function by the energy resulting from the expansion of compressed air. The basic purpose of any air tool is to supplant tedious manual labor with the far more rapid and efficient method of automatic operation. This is accomplished by subjecting the working end of the tool to rotation, percussion (or rapid hammering), constant pressure, or a combination of impact and rotation.

Rotary Vane Tools

Speed is the essence of any mass production job. The assembly line must not stop. In war-time it



Courtesy of Ingersoll-Rand Company

Fig. 1—Details of an I-R aircraft riveting hammer. Before starting, pour a small quantity of oil into the air inlet. In service, add about half a teaspoonful of oil every two or three hours of operation.

might spell the difference between success and failure at some foreign beach-head. In peace time it might upset a carefully planned production and cost program.

The principle of the rotary vane pneumatic tool was the answer to this plea for speed. The design is based upon an air-driven rotor fitted with suitable vanes. This rotor drives the working point of the tool either through direct drive or suitable reduction gearing. The ultimate speed of the working point depends upon the service and the type of tool.

The rotary vane air tool is very versatile. It can be built to drill, ream, countersink or tap. It can serve as a screwdriver or can be used as an impact wrench to run nuts on or off bolts. It can be used as a grinder, surfacer or sander. There are numerous other specialized uses.

This type of air tool is possessed of certain outstanding features:

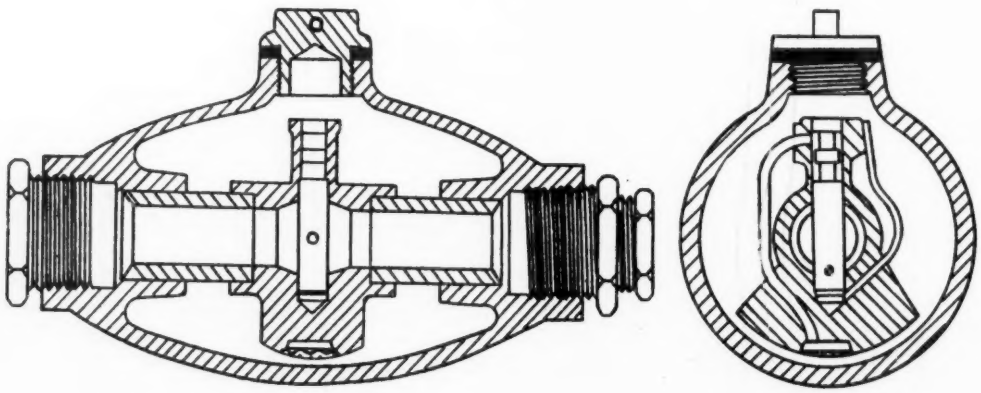
— It runs on ball bearings
— It generally has a built-in lubricator
— Attachments can be readily changed
— Flexibility of control is excellent

Lubrication Requirements

Quite naturally, to function at its best, the rotary vane tool must be properly lubricated. The main parts to be lubricated include: (a) The vanes and cylinder; (b) the reduction gears; (c) the bearings.

Vanes and Cylinder

The vanes and cylinder require a high grade mineral oil of from 100 to 500 secs. Saybolt Universal Viscosity at 100° Fahr. according to the temperature, speed and load. Chemical stability is an



SECTIONAL VIEW

CROSS SECTION THROUGH PENDULUM

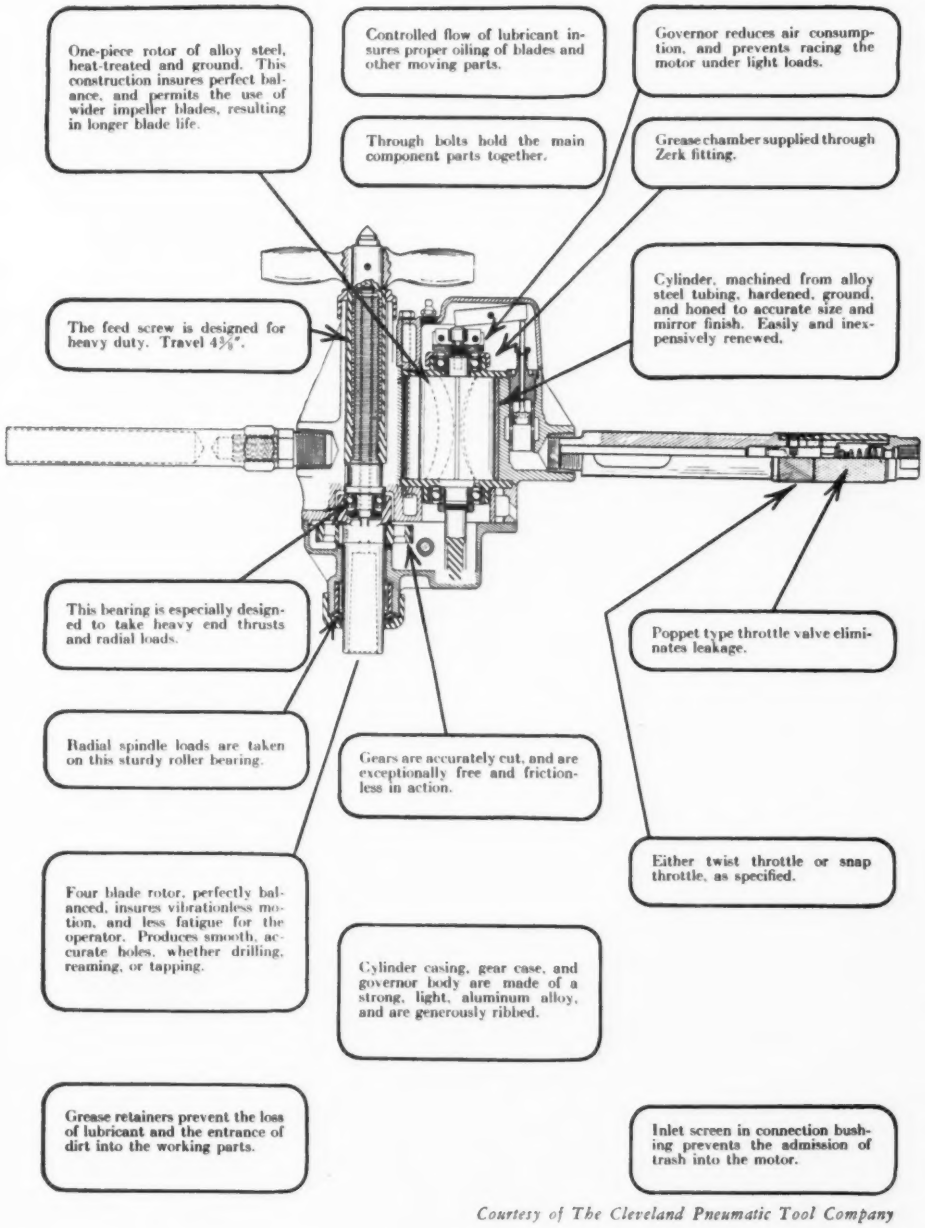
Courtesy of Chicago Pneumatic Tool Company

Fig. 2—The C-P line oiler. This is attached to the air hose ten or fifteen feet from the tool. It automatically furnishes finely atomized oil to all tool parts. Refill oiler every four hours. Keep needle valve properly adjusted.

important feature in such an oil; resistance to oxidation and gum formation is most essential. Rust prevention is equally important. This can be assured by proper selection of the lubricant. In some designs the oil supply is carried in reservoirs in the tool and delivered to the air stream through a felt feeder. In other designs a line-oiler may be installed. Sometimes a combination of both is used.

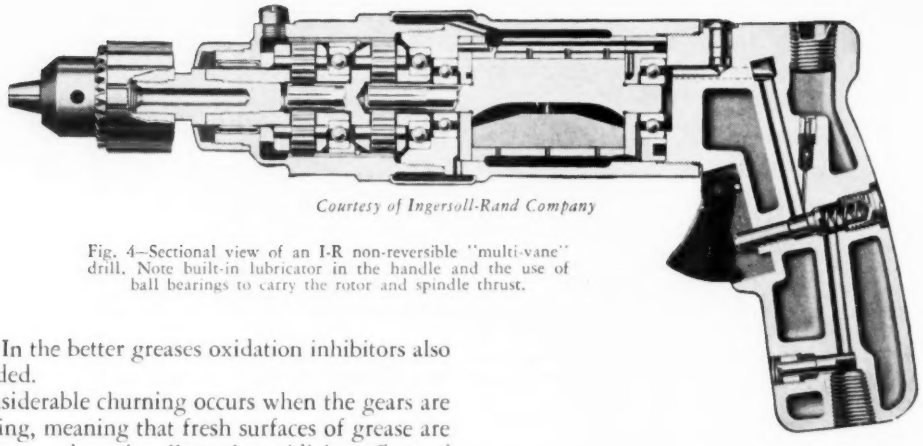
The Gears and Bearings

The planetary gears and bearings are grease lubricated by pressure gun through suitable fittings. The grease should be a product manufactured particularly for this type of service. It should be prepared from selected fatty oil soaps and mineral oils which are of proven stability, so that the final grease will have adequate resistance to oxidation and gum-



Courtesy of The Cleveland Pneumatic Tool Company

Fig. 3—The Cleco air drill showing details of the 4-blade rotor and other essential parts.



Courtesy of Ingersoll-Rand Company

Fig. 4—Sectional view of an I-R non-reversible "multi-vane" drill. Note built-in lubricator in the handle and the use of ball bearings to carry the rotor and spindle thrust.

ming. In the better greases oxidation inhibitors also are added.

Considerable churning occurs when the gears are operating, meaning that fresh surfaces of grease are being exposed continually to the oxidizing effects of air. These effects normally will be accelerated by the increase in temperature which develops due to internal friction in the lubricant itself. Obviously, oxidized gummy accumulations around the gears and bearings will prevent free rolling and therefore should be eliminated by the use of a suitable grease.

The Percussive Type

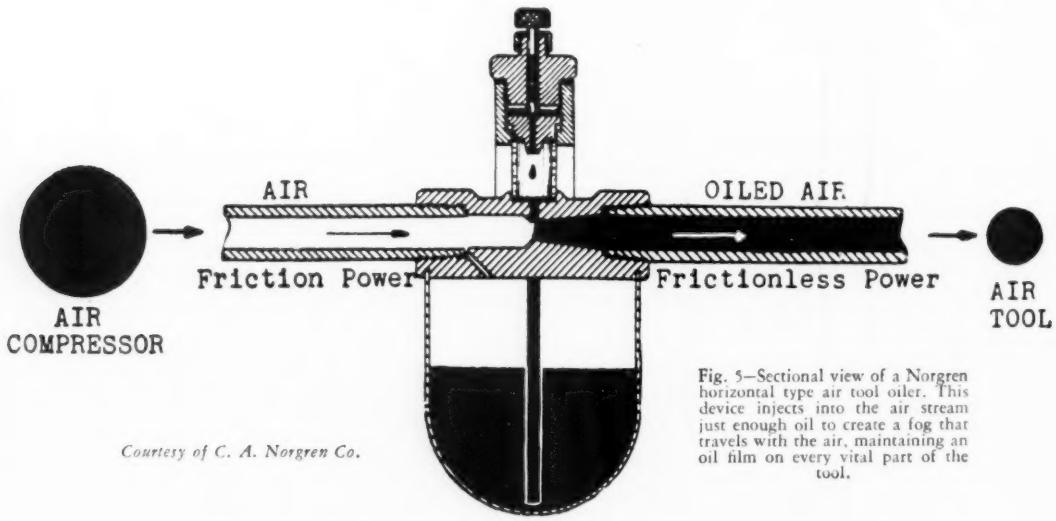
Where percussive action is employed, air pressure acts on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. In other words, the tool mechanism involves a cylinder with suitable companion piston and valve arrangement for the admission of air at the proper time, according to the number of strokes per minute or percussive frequency required.

Two sets of valves are normally involved; i.e., the throttle valve by which the operator controls the amount of air admitted, and the working valve, which, through suitable timing, controls the frequency with which the air pressure is allowed to react on the piston. As the piston moves back and forth within the cylinder of a percussive type tool, it strikes rapidly upon the head of the working tool.

Lubrication

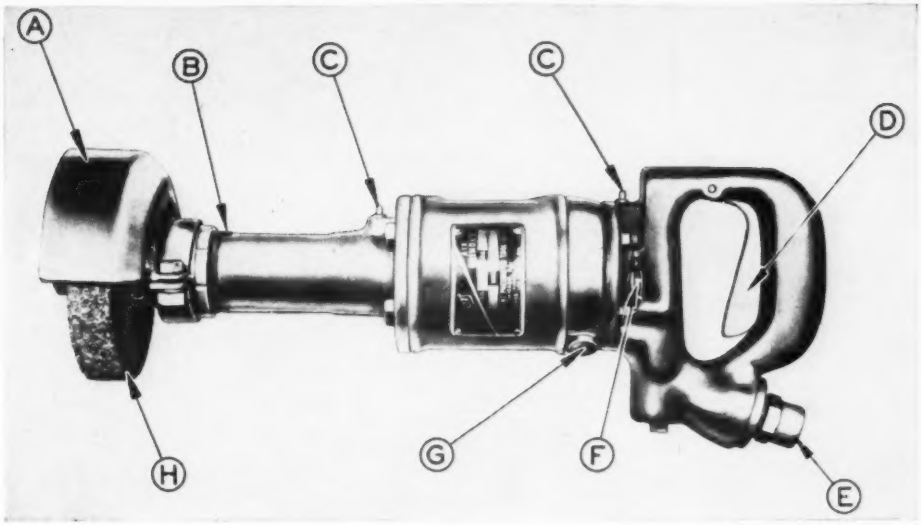
Those parts which require lubrication include the cylinder, the reciprocating piston, the working valve mechanism and the throttle valve. The main moving parts, of course, are the piston and working valve.

The lubricant for this type of tool must be such as to adequately lubricate with the least amount of internal friction and tendency to oxidize to form gummy deposits. In consequence, lubricants for this purpose must be selected with the utmost care. This calls for an oil of the lightest viscosity compatible with the temperature and load. Oils are



Courtesy of C. A. Norgren Co.

Fig. 5—Sectional view of a Norgren horizontal type air tool oiler. This device injects into the air stream just enough oil to create a fog that travels with the air, maintaining an oil film on every vital part of the tool.



Courtesy of Independent Pneumatic Tool Company

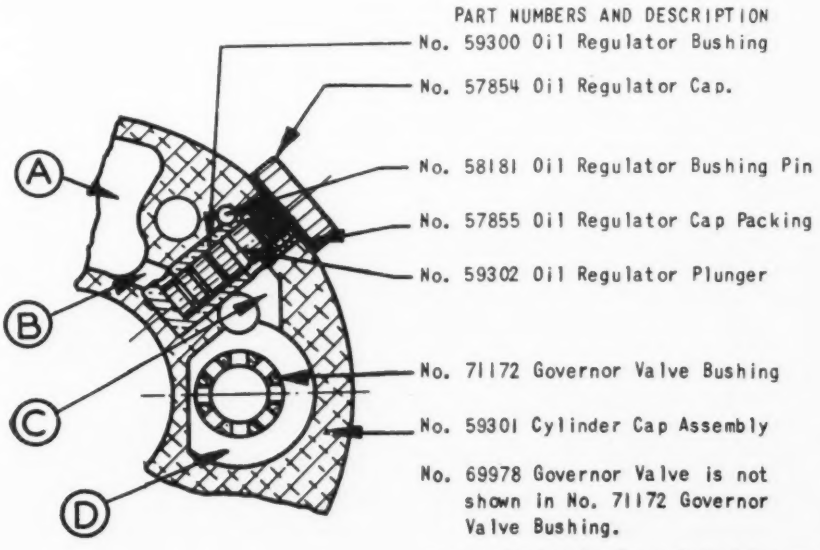
Fig. 6—Identification of a Thor pneumatic rotary grinder. A—shows the grinding wheel guard assembly; B—the oiler on the spindle support; C—grease lubrication nipples; D—the throttle trigger; E—the air inlet reducer with strainer; F—the oil reservoir plug; G—the oil regulator cap; and H—the grinding wheel.

avaliable either compounded or containing additives which will emulsify in contact with moisture, and resist oxidation, so that protection of the tool parts will result and valve sticking will be prevented.

Due to modern tool construction there is but little possibility of dirt or grit entering to contaminate the lubricant. The tool parts should, therefore, function for indefinite periods if properly lubricated.

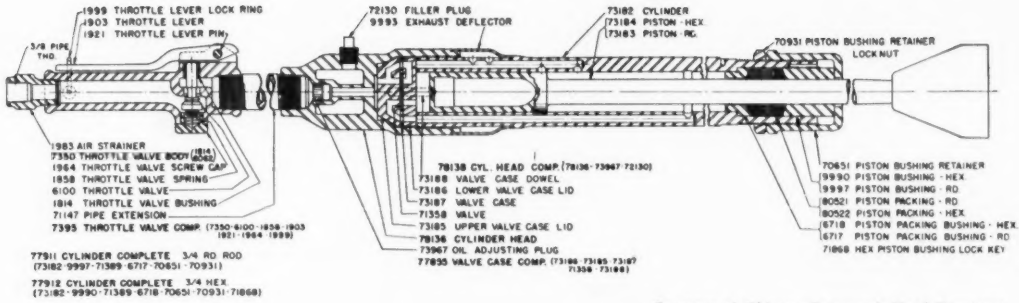
Continuous Lubrication

As air—the motivating power is constantly being exhausted from the tool, the lubricant is being constantly carried out with the exhaust. The lubricant supply, must, therefore, be regularly renewed; otherwise, there will be impaired lubrication. Only a limited quantity of oil is carried in the air line oiler or in the internal reservoirs of the average



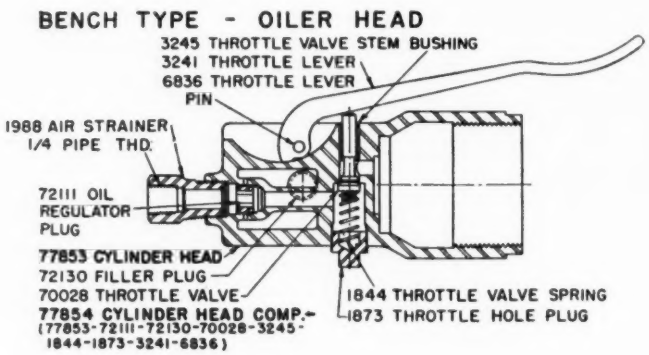
Courtesy of Independent Pneumatic Tool Company

Fig. 7—Details of the oil regulator unit for a Thor pneumatic rotary grinder. Oil in reservoir (A) is carried by the air through channel (B) around the oil regulator plunger, and through channel (C) into chamber (D) from whence it is carried into the motor through the governor valve bushing.



Courtesy of Chicago Pneumatic Tool Company

Fig. 8—Details of the C-P-2 Simplate rammer and backfill tamper. Above, note parts identification. Below, are shown details of the Bench type oiler head.



tool; hence frequent refilling is necessary. Larger reservoirs would necessitate more metal and heavier tools.

GENERAL LUBRICATION AND CARE OF AIR TOOLS

Many such tools are used under more or less severe operating conditions which include water, dust, dirt and heat.

Water, for example, will tend to wash off the lubricating film from the wearing surfaces. During storage it can cause rust. For this reason, oils which will wet the steel parts and prevent contact with water, are recommended.

Such lubricants create an adhesive protective film which adequately resists the washing effects of water and sticks tenaciously to all wearing elements.

The Means of Lubrication

The means by which lubricants are applied or distributed has a marked effect upon the operation of air tools. Even the best of oils or greases may fail to do their work if they are carelessly used, or in such a manner as to be unable to reach all the wearing elements of the tools. More failures or complaints arise from insufficient or no lubrication than from any average operating condition. In many cases, this will be due to ignorance; in others, due to neglect often because operators do not appreciate the necessity for lubricating their equipment.

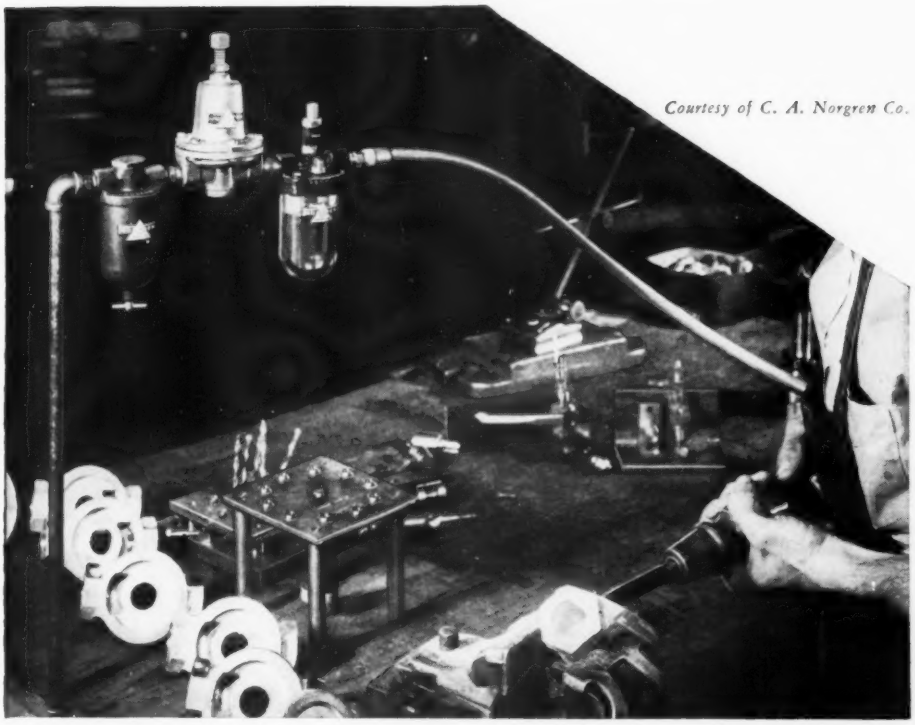
The operator must use his products intelligently, in accordance with the recommendations of the builders of his tools, and the oil company from whom he purchases.

Air Line Oilers

Air line oilers work on the principle of atomization. The air in its passage through the oiler draws the requisite amount of oil from the reservoir by suction. This method of feeding insures effective distribution to all parts of the tool with which it comes in contact. The capacity of the lubricator depends upon the volume of air required by the tool.

Dust and Dirt Are Abrasive

Careless handling in the presence of dust and dirt which may enter the tool along with the dirt which may be carried through the tool by the air itself will be always a potential cause of wear. Normally it is easy to prevent abrasive foreign matter from entering the tool itself via the airline if an air filter is installed and if the hose is in good condition. Care in handling when not in actual operation will prevent dirt entering from other sources. If the tool is stored in an oil bath or rested in a position or locality free from dirt when not in use it should



Courtesy of C. A. Norgren Co.

Fig. 9—A Norgren filter, regulator and lubricator servicing a small hand tool. Note the transparent oil bowl which enables observation of the oil supply and feed.

function satisfactorily for an indefinite period.

Clean air should always be used. This condition will depend however upon the location of the compressor, its air intake, whether or not air filters are installed, and the cleanliness of the inter-coolers, pipe lines and air hose. Furthermore, if any of the parts are rusted on the interior surfaces, particles of rust may flake off and be carried along by the air.

To keep out particles of rubber from the air hose and gaskets which would interfere with the free operation of the tool mechanisms, some authorities recommend locating a strainer in the inlet pipe. Some builders include a strainer in the tool itself. Strainers should effectively remove the greater part of any solid foreign matter and protect the working mechanisms of the tool. The strainer must be cleaned at frequent and regular intervals.

Automatic lubrication by means of air line oilers or atomizers mechanically delivers the requisite amount of clean oil to the air lines. Lubricators of this type prevent contamination of the oil from exterior sources if the fresh oil is kept clean. Any oil containers used on the job must be of the closed-cover type to assure of this.

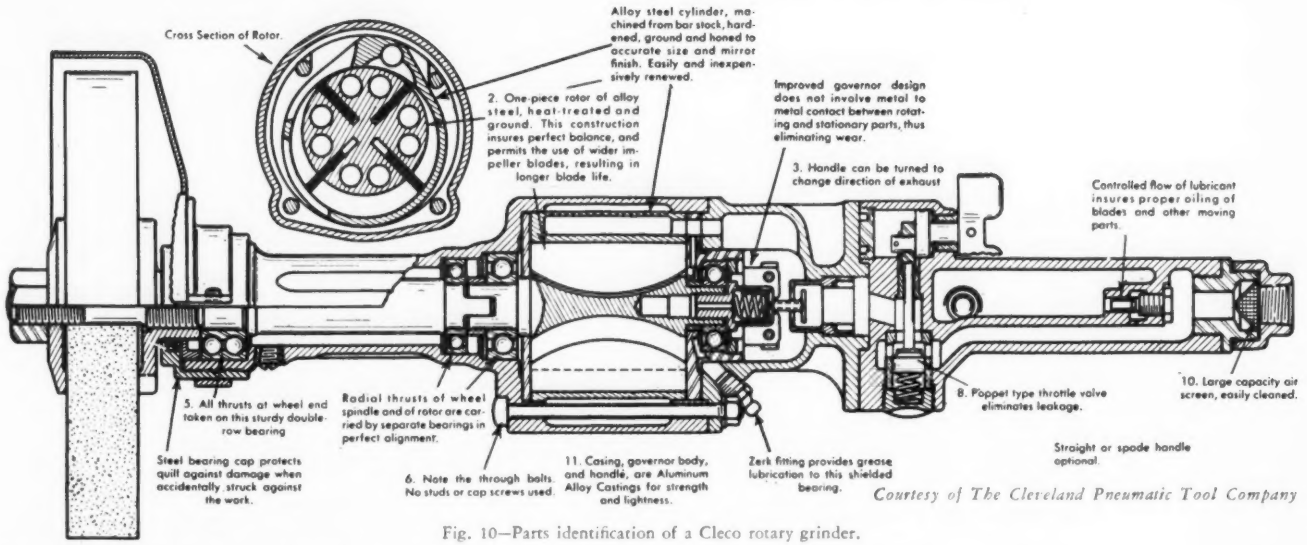
In the absence of automatic means of lubrication, tools must be periodically oiled by hand. There will be more possibility of accidental entry of dust or dirt occurring under such conditions. At best, operators' hands will be dirty, and in some localities the atmosphere will often be laden with dust. The lubricants should be stored and handled with even greater care. They should be kept in closed containers where they will be handy and eliminate loss of time when lubricating.

NATURE OF THE LUBRICANT BEST SUITED TO AIR TOOL PROTECTION

Moisture is the cause of rust. If the lubricants used do not protect the tool parts from rusting, especially when the tool is idle, up goes the cost of maintenance and replacement.

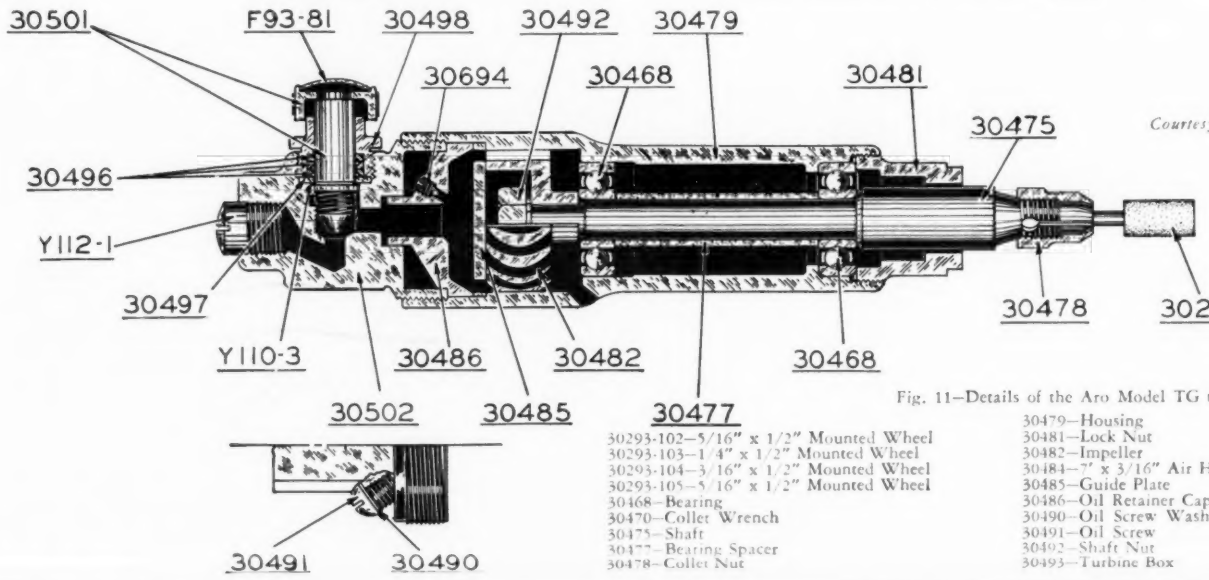
Oil and Rust Resistance

Oil is required to lubricate those parts of the air tool which are contacted by compressed air. This means that if the air is moist (as most compressed air is) rusting may occur if the oil does not contain materials to prevent rusting. The chemist *call this preferential oil-wetting of the steel surfaces in the presence of moisture.*



Courtesy of The Cleveland Pneumatic Tool Company

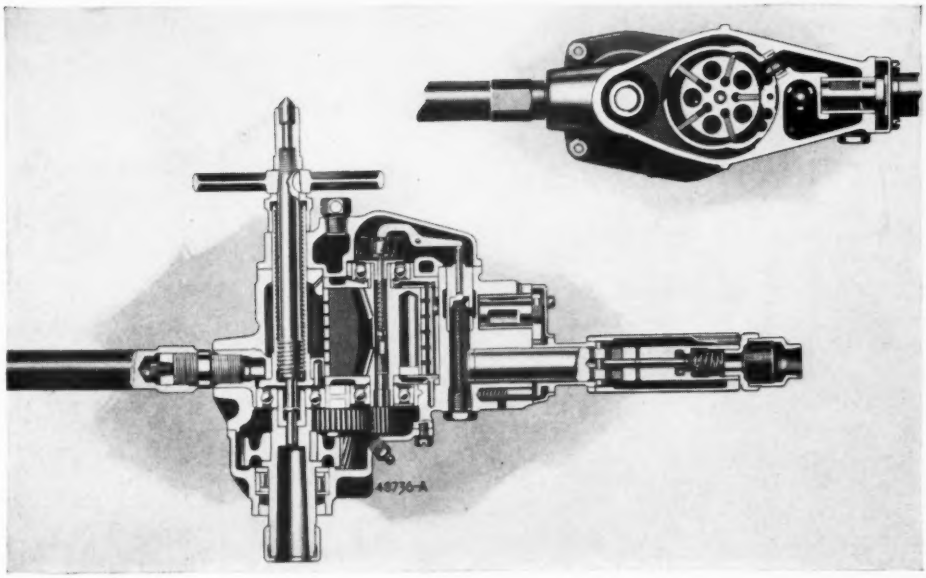
Fig. 10—Parts identification of a Cleco rotary grinder.



Courtesy of The Aro Equipment Corporation

Fig. 11—Details of the Aro Model TG turbine grinder.

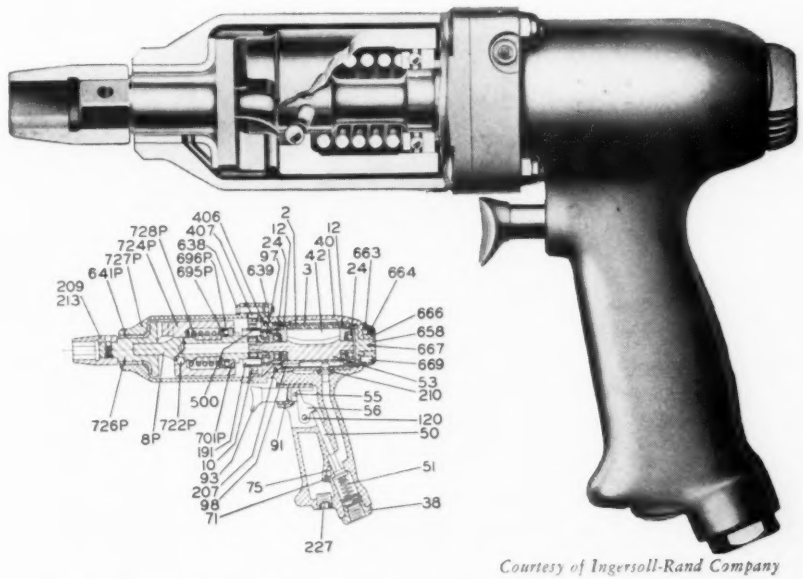
30293-102—5/16" x 1/2" Mounted Wheel
30293-103—1/4" x 1/2" Mounted Wheel
30293-104—3/16" x 1/2" Mounted Wheel
30293-105—5/16" x 1/2" Mounted Wheel
30468—Bearing
30470—Collet Wrench
30475—Shaft
30477—Bearing Spacer
30478—Collet Nut
30479—Housing
30481—Lock Nut
30482—Impeller
30484—7" x 3/16" Air Hose
30485—Guide Plate
30486—Oil Retainer Cap
30490—Oil Screw Washer
30491—Oil Screw
30492—Shaft Nut
30493—Turbine Box
30494—Dressing Stone
30496—Seal
30497—Washer
30498—Valve Nut
30501—Valve Post
30502—Head
30507—Tool Post Clamp
30694—Oil Regulator
F93-81—ARO Disc
Y110-3—Snap Ring



Courtesy of Ingersoll-Rand Company

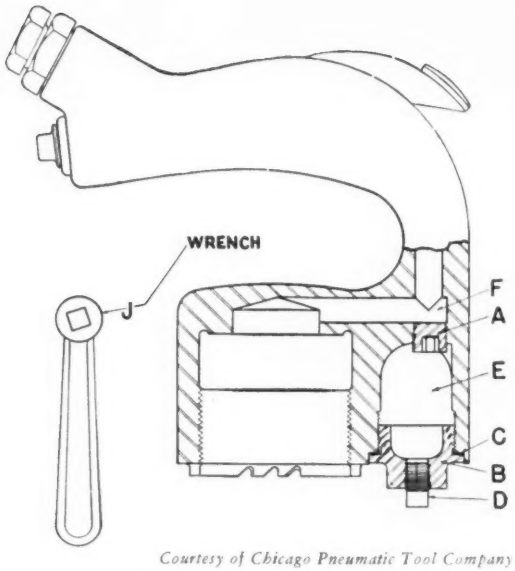
Fig. 12—Sectional view of an I-R reversible "Multi-vane" drill. An adjustable automatic oiler continuously feeds metered amounts of oil to the motor. All rotating parts are supported by anti-friction bearings. The rotor bearings are seal plate type to exclude dirt and retain grease.

It is quite true that highly refined straight mineral oils are capable of providing adequate lubrication and protection of tools wherever *dry* air is available, but absolute *dryness* is never attainable. If the air lines are laid out so that drainage of condensed moisture to traps is assured, if these traps are drained regularly, if effectual water filters are used, if an after-cooler is installed at the compressor — then it is justifiable to assume that moisture-free air is being delivered to the tool. Only under these ideal conditions could a straight mineral oil be expected to provide satisfactory lubrication.



Courtesy of Ingersoll-Rand Company

Fig. 13—Cutaway section and details of the I-R size 504 impact wrench. Of specific interest herewith are parts No. 22 and 24, the rotor bearings; No. 71, the oiler adjusting screw; No. 75, the oiler feed; and No. 227 the oil chamber plug.



Courtesy of Chicago Pneumatic Tool Company

Fig. 14—The built-in lubricator for C-P chipping hammers. To fill, remove filler plug "D" with wrench "J". "A" is the Regulating Plug. Screwed in snugly, it allows very slow seepage of oil past threads from oil chamber "E" into live-air port "F". Air in chamber gradually builds up to line pressure and fluctuations allow oil mixed with air to work out. "B" is Oiler Cap which must be screwed down tightly on gasket "C".

Since ideal conditions do not exist at all times, complete protection against rusting can only be expected by use of a lubricant which will provide rust protection.

During Storage

This type of oil which will wet steel surfaces and prevent contact with moisture is excellent insurance against rusting when air tools are not in use or must be stored for any length of time.

Stability

This characteristic in a lubricant applies both to oils and greases. Briefly, it involves resistance to oxidation.

Fortunately, extreme pressure conditions do not prevail in portable air tools as they do at the rifle-bar of a rock drill, so E.P. characteristics are not necessary in small tool lubricants at this time. In lubricating small tools (along with rust prevention) it is more important to consider the stability of the lubricants, keeping in mind the fact that such tools are precision mechanisms designed with close tolerances and intended to operate at high speeds. As suggested elsewhere, particles of rust, metal, dust or hose material, if accumulated in the tool, can necessitate time out for overhaul Suitable lubricants prevent the accumulation of foreign matter by gummy material.

Resistance to Oxidation

How the oxidation process progresses was shown in LUBRICATION for July. It is a process which is accelerated by heat. Just another reason why the air system should include an after-cooler at the compressor, so that cool air will be delivered to the tools.

Resistance to oxidation is not indicated by any specific laboratory test which is quoted when purchase and sale of lubricants is involved. The oil refiner could furnish laboratory test figures to prove the ability of any specific lubricant to resist oxidation, but such data would only be confusing, for unfortunately some of the procedures for measuring this characteristic are non-convertible in terms of performance.

Thus "A" oil, tested by the "X" method could not be considered better or worse than "B" oil (a different product) tested in another laboratory by the "Y" method. Service performance is the ultimate criterion.

LUBRICATION SERVICE

The integrity of the oil refiner, his ability to manufacture dependable lubricants and the reputation of his lubricants are the best guarantee for proper lubrication.

This means that once the source of the lubricants has been decided upon, the purchaser only needs to check viscosity ranges, or consistencies, and operating temperature characteristics of the proposed lubricants. He should compare these with the tool builders' specifications (if any have been adopted); he should look into the performance data obtainable from his oil supplier. Then he is in position to buy lubrication service, not just lubricants. Emphasis on lubrication service will react in lower maintenace costs and less time out for repair. When contract dates must be met, that means a lot.

SELECTING THE LUBRICATOR

Choice of the means of lubrication is largely the responsibility of the air-tool manufacturer. Tool weight and bulk are important considerations. The objective is to keep these as low as possible.

An advantage possessed by the air line oiler is that it serves as a visible reminder to the operator that re-lubrication is necessary periodically; it also holds more oil; that means less attention. On the other hand, the built-in-oiler on a rotary drill for example, is advantageous in that a self-contained unit is available and because of its location it provides more positive lubrication. Best assurance of dependable lubrication is provided by a combination of both.

WHEN TO RE-OIL

Air tool engineers suggest placing a piece of white paper across the exhaust to tell when to re-oil. As long as oil droplets appear on the paper, oil is passing through the tool.

Study of operating conditions, the length of time the tool is used and the capacity of the oiler, should furnish data from which the frequency of re-oiling can be determined. The resultant schedule should be carefully followed. Lack of lubrication can very soon cause the vanes of a rotary tool to warp, burn, chip and crack. True, new vanes are cheap and can be readily renewed, but the tool is out of service meanwhile. In the percussive type tool scoring of the contact surfaces will result.

TAKE CARE OF THE AIR

Transmission of air from the compressor to the air tool involves a number of stages; compressor to pipe line to air hose to tool. The air hose is most important. If it is not properly cared for, it can develop leaks, become frayed, and accumulate condensed moisture. Then tool production suffers.

Care of the air transmission system (hose and pipe line) can be summarized as follows:

1. Check valve from line to tool. This should be open wide.
2. Blow out line before attaching tool. This will help remove water, rust and foreign particles.
3. Restricted connections reduce flow of air. Remove if possible.
4. Don't connect an auxiliary air line to the bottom of a tee. Moisture may be trapped therein.
5. Use short, large diameter air lines to avoid excessive pressure loss.
   A large feeder hose, for example, ¾", may be used with a lighter, flexible type hose, as a "whip" between the tool and feeder hose. This provides ample air pressure up to a point close to the tool, and gives the added advantage of light weight and flexibility on the section next to the tool itself.
6. Plan on regular inspection of air lines so they can be kept in good condition.
7. Use high quality hose, built with a lining which will resist the deteriorating effect of oil and heat.
8. Plan on cooling the air before usage. An after-cooler installed at the compressor is an excellent investment. It is effective in removing heat, oil, and water from the air before usage.

WATCH THAT WATER

As indicated elsewhere in this article, water can accumulate through condensation. Condensation in some localities can become very serious. Whenever air cools in the air lines vapor will condense if the moisture content of the air is high. The resultant water, carried through the tools by the air may wash off certain types of lubricants, or freeze in the valves and ports if the tool is idle under sub-freezing conditions.

A two-stage air compressor system will eliminate water in many cases by subjecting the air to cooling before usage. The same holds true for a single stage unit equipped with an after-cooler. Here any water present can be trapped out at the cooler.

Suitable drains in the air lines also are helpful provided they are blown out frequently.

Another effective preventive is to blow out the air lines before connecting the tools. This has the added benefit of removing particles of hose rubber, rust or other foreign matter which might stop up or cause wear of the vanes or other parts of the tool.

CLEANING PROCEDURE

Even with the best of care and lubrication, air tools should be dismantled and cleaned periodically. Preventive maintenance defines the purpose. The pay-off is better tool performance, longer tool life.

Cleaning can best be accomplished by using a solvent such as kerosine or Stoddard Solvent. Normally, these will cut any gummy residues and enable them to be washed out. Where greases are used more care must be exercised in cleaning out all traces of used lubricant.

Small percussive type tools can be effectively freed of non-lubricating accumulations and old lubricants by submergence in a bath of a suitable cleaning fluid for a few hours; then blowing out thoroughly with air. Large tools, however, may require disassembling when cleaning is necessary. If the tool has been laid up for any length of time, the parts should be soaked in solvent to soften or cut any gummy matter and permit easy washing off of such other foreign residuum which may not be entirely soluble.

Accumulations of foreign matter can be prevented by suspending percussive type tools in a bath of light oil whenever they are not in use. This will prevent oxidation by eliminating contact with air, otherwise, were the latter at all moist, it would promote the formation of rust, corrosive matter and gummy residues from certain classes of lubricants. Prior to re-usage the tools should be blown out and thoroughly re-lubricated.

Storing in a *rust-preventive* light oil bath is a definite advantage.

AIR TOOL PERFORMANCE CAN BE AFFECTED BY A NUMBER OF CONDITIONS

HOW	WHY
By the Wrong Types of Lubricants.	Gumming, rusting or corrosion will occur.
By Insufficient Lubrication Due to none or too little lubricant.	The resultant oil film may not be able to prevent overheated bearings, wear, scoring, or rusting of the tool parts.
Faulty lubricators, or using the wrong type of lubricant.	The Bakelite vanes in a rotary vane tool warp, chip and crack readily when not lubricated.
By Dust and Dirt Carried in by unclean air. By careless handling under dirty operating conditions.	Because dust and dirt promotes wear of tool parts.
By Rubber Particles from Hose Flaked off of old or deteriorated hose or gaskets.	Inteferes with free motion of tool mechanisms.
By Water Getting in with moist air.	Water causes rust and corrosion, which can be prevented by selection of the proper lubricant. Water also can freeze to ice. Air in passing through a tool expands with a resultant temperature drop. This may cause frosting or actual freezing of the exhaust ports, thus causing restriction and power loss. Incidentally, the more efficient the tool, the greater the per cent of expansion therein, hence the greater the temperature drop.
By Rust Formed due to contact with moisture.	Rust interferes with free motion of tool mechanisms and causes wear.

TROUBLE SHOOTING

SIGNS OF TROUBLE	REMEDY
Sluggish Operation Due to gummy lubricant	Clean tool parts thoroughly with kerosene, Stoddard Solvent, or a mixture of light lubricating oil and kerosene. Check the air strainer, if one is installed. It is used to keep abrasives and dirt from entering the tool. If it becomes clogged it will reduce the air flow. Remove and clean regularly.
Tool Noise Indicative of worn parts.	Dismantle tool and renew any worn parts before they can cause damage to other parts. Check suitability of the lubricant. Check regularity of lubrication. Check for presence of foreign matter in air. Check water removal routine.
Uneven Operation	Look for stuck vanes. Free the working parts and relubricate.
Stuck Operating Parts	Variations in speed indicate that gummy deposits may be the cause. Dismantle, clean, replace any worn parts; then relubricate. Never install new parts along with badly worn parts. Neither can function effectually when so combined.
Insufficient Air Pressure	Check for leaks in the air line, or obstructions. When the air pressure is below that for which the tool is designed, tool efficiency or output will be reduced. Check for ample hole openings through hose couplings, nipples, and menders. Often a drop of 10% or more in air pressure between the supply line and tool itself can prevail due to excessive length, improper size or undue restrictions in the hose length.

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REGAL OILS (R&O)
FOR
PNEUMATIC TOOLS

A LOT of revolutionary ideas have developed during these recent war years. Some will certainly flourish in the postwar era. Rust prevention of iron and steel parts is one of the most promising; and rightly so, considering the vast tonnage of rustable machinery which has to be delivered to the various war theatres — *ready to go.*

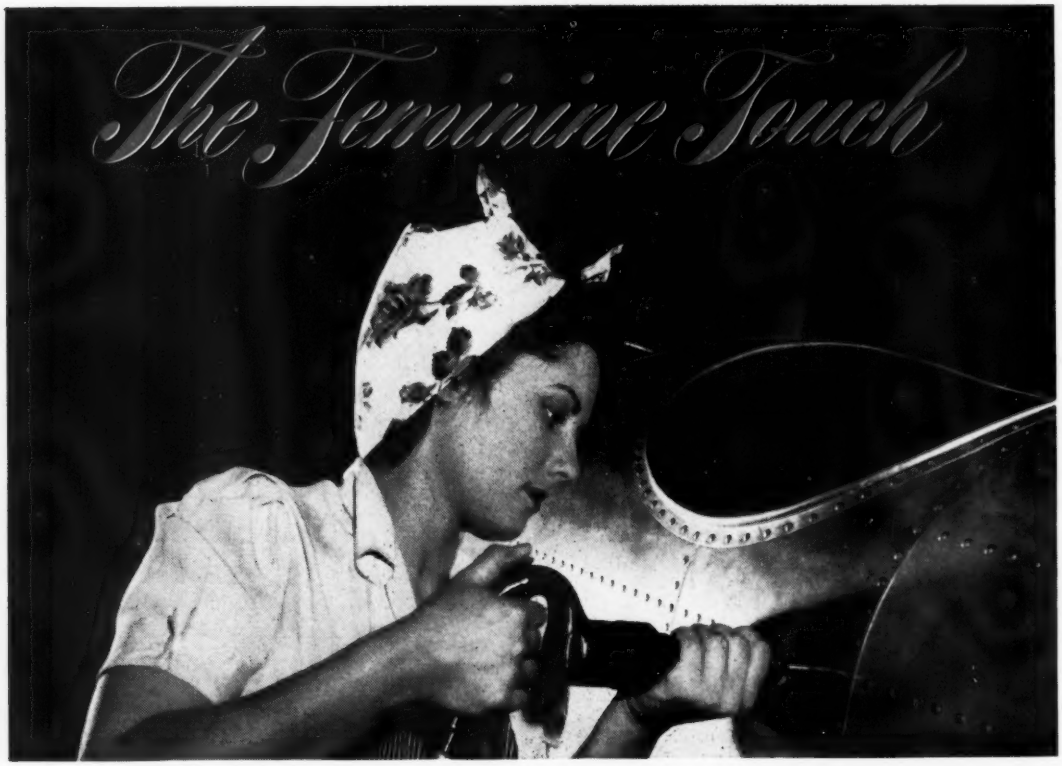
This means that the chemist had to study rust inhibiting additives; the lubricating engineer had to subject vast numbers of laboratory concoctions to field test; the military proved or disproved their value in ocean transport.

Symbolic of this research are the rust and oxidation inhibitors which today are component parts of all *Texaco Regal Oils (R&O).*

Industry bids fair to profit immensely therefrom. Steam turbines will be lubricated more dependably; air tools will be operated more economically; time out for repairs will be reduced; idle machines will go through stand-by periods more safely.

Pneumatic tools (collectively) are a most important part of the assembly of production machinery in American Industry. They are precision mechanisms, their tolerances are very close. Rust-free they are a vital key in any mass production program. Rusted, their parts may be only good for scrap.

The problem of rust-prevention has been solved by application of the theory of polarity of molecules. *Texaco Regal Oils (R&O)* put this theory into practice.



THIS woman war-worker, using an air-operated riveting hammer is giving this highly skilled operation "the feminine touch".

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Texaco Alcaid, Algol or *Ursa Oils* keep compressors free from harmful gum, sludge and hard carbon deposits. Valves open wide and shut pressure-tight; rings stay free, ports and air lines clear.

Texaco lubricants have proved so effective in service they are definitely preferred in many fields, a few of which are listed at the right.

A Texaco Lubrication Engineer will gladly cooperate in the selection of the most suitable lubricants for your equipment. Just phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write: The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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